

## Line Mixing Behavior of Hydrogen-Broadened Ammonia Under Jovian Atmospheric Conditions

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### ABSTRACT

[Laboratory spectra] data reported last year have been used to investigate the line mixing behavior of hydrogen-broadened ammonia inversion lines. The data show that broadening parameters appearing in the modified Ben-Reuven opacity formalism of Berge and Gulkis [1976] can maintain constant values over pressure ranges that include low to moderate pressures and high pressures. Also, they cannot change drastically in value, as in the Spilker [1990] revision of the Berge and Gulkis formalism. For hydrogen pressures less than about 10 bars the hydrogen broadening parameter  $\gamma$  must be very near 2.0 MHz/torr. But at very high pressures (tens to hundreds of bars) it must be near the Berge and Gulkis value of 2.318 MHz/torr to be consistent with the data of Morris and Parsons [1970]. In contrast, the newer data show that the value of the associated line mixing parameter  $\zeta$  must change significantly with pressure, but in a manner different from that of the 1990 Spilker revision. This variation in  $\zeta$  resolves the apparent dichotomy between Ben-Reuven based formalisms and Van Vleck-Weisskopf formalisms. It has long been recognized that at low pressures, less than about 1 bar of a Jovian atmospheric mixture, a VVW formalism yields more accurate predictions of ammonia opacity than Ben-Reuven formalisms. At higher pressures the Ben-Reuven formalisms are more accurate. Since the Ben-Reuven lineshape collapses to a VVW lineshape in the low pressure limit, this low pressure inaccuracy of the Ben-Reuven formalisms is surprising. The data reveal that the collapse of the Ben-Reuven lineshape to VVW is accelerated by a rapid decrease in  $\zeta$  as pressure decreases below about 2 bars, reaching  $\zeta=0$  at zero pressure. Fitting various functional types to the data shows that an arctangent function with two free parameters best describes the  $\zeta$  variation in the zero to 10 bar range. Incorporating this behavior produces a new formalism that is more accurate than previous formalisms, particularly in the critical "transition region" from 0.5 to 2 bars, and that can be used without discontinuity from pressures of zero to hundreds of bars. The new formalism will be useful in such applications as interpretation of radio astronomical and radio occultation data on giant planet atmospheres, and radiative transfer modeling of those atmospheres.

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